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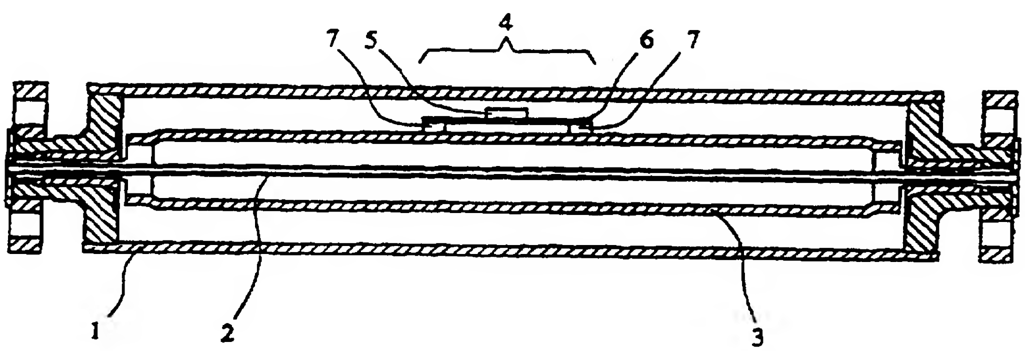
(54) **Mass flow meter**

(57) The invention concerns a mass flow meter for measuring flowing media, the flow meter operation according to the Coriolis principle and comprising a preferably cylindrical, in particular circular cylindrical, housing (1); at least one, preferably substantially straight, Coriolis measuring tube (2) which is disposed inside the housing (1) and is connected at both ends to the latter a preferably cylindrical, in particular circular cylindrical, bridge (3) disposed on the Coriolis measuring tube (2); at east one oscillation generator which acts on the Coriolis measuring tube (2); and at least one measuring sensor which detects Coriolis forces and/or Coriolis oscillations based on Coriolis forces. With respect to the centre point of the Coriolis measuring tube (2), the bridge (3) is disposed and designed symmetrically relative to the ends of the Coriolis measuring tube (2) which are connected to the housing (1), the oscillation generator and the measuring sensor being active between the Coriolis measuring tube (2) and the bridge (3). According to the invention, the bridge (3) is provided with an equalizing system (4) which is designed symmetrically and is disposed substantially symmetrically to the centre point.



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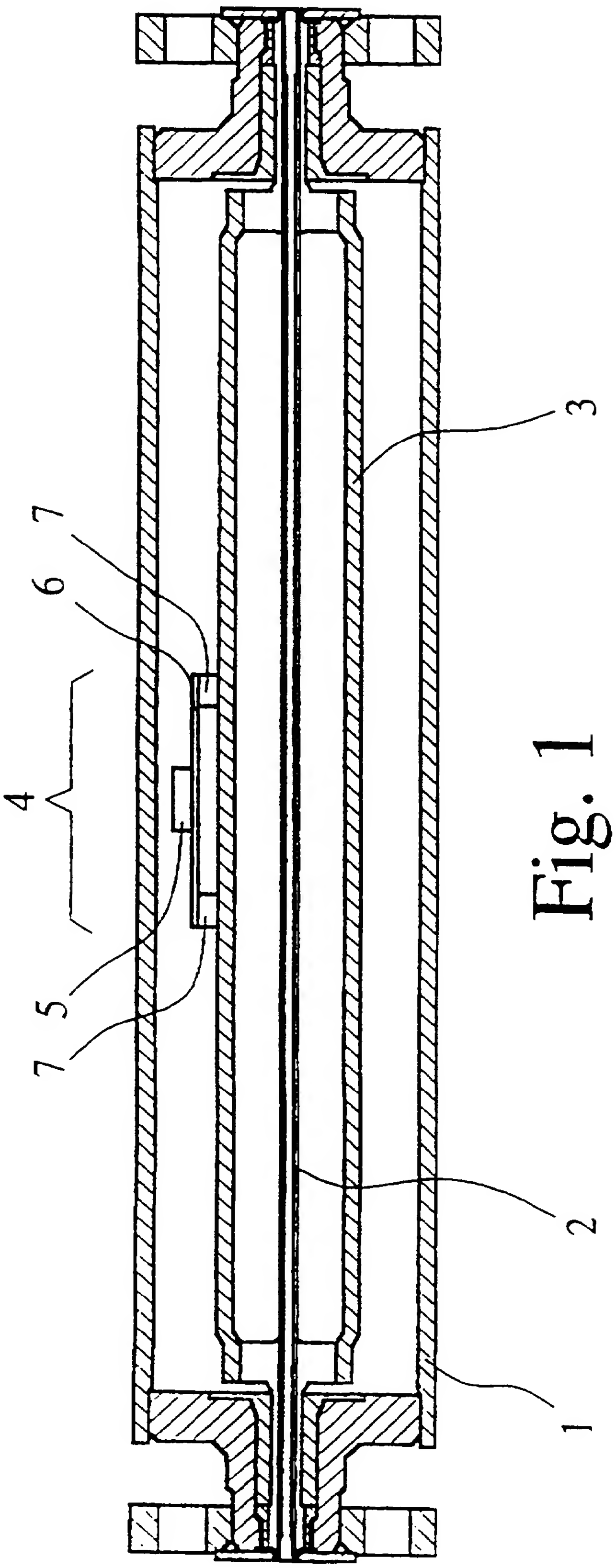

Fig. 1

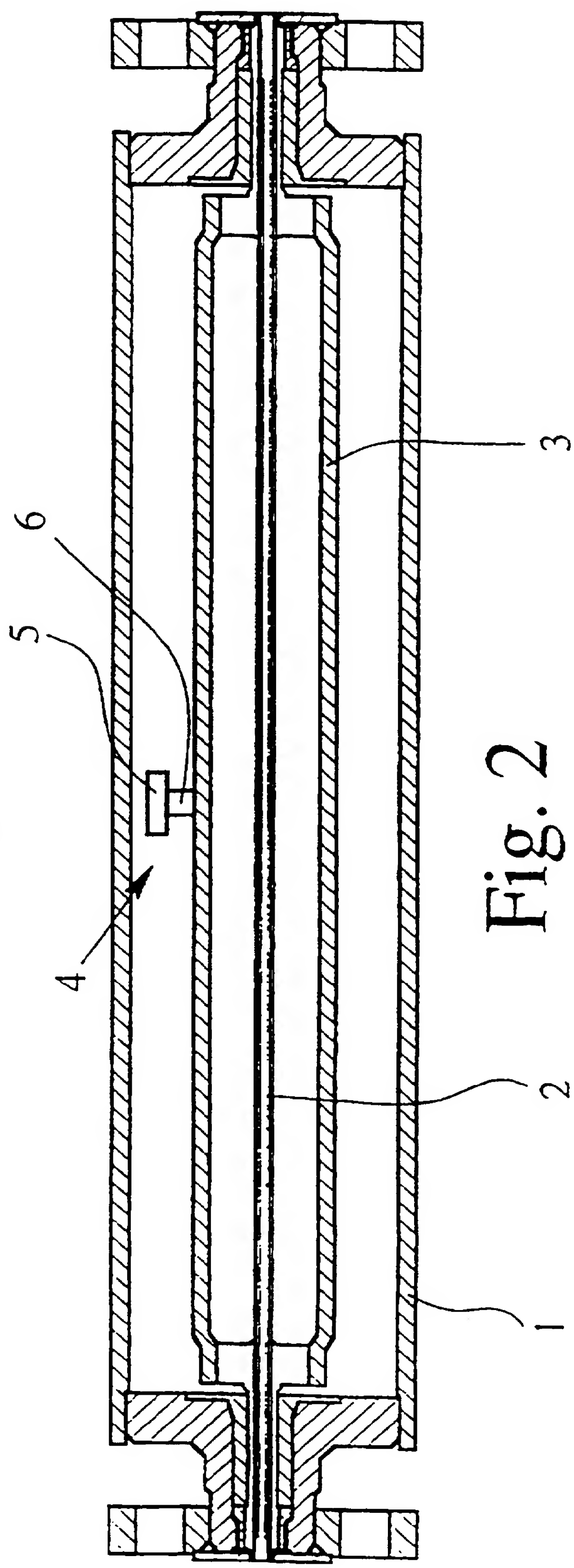

Fig. 2

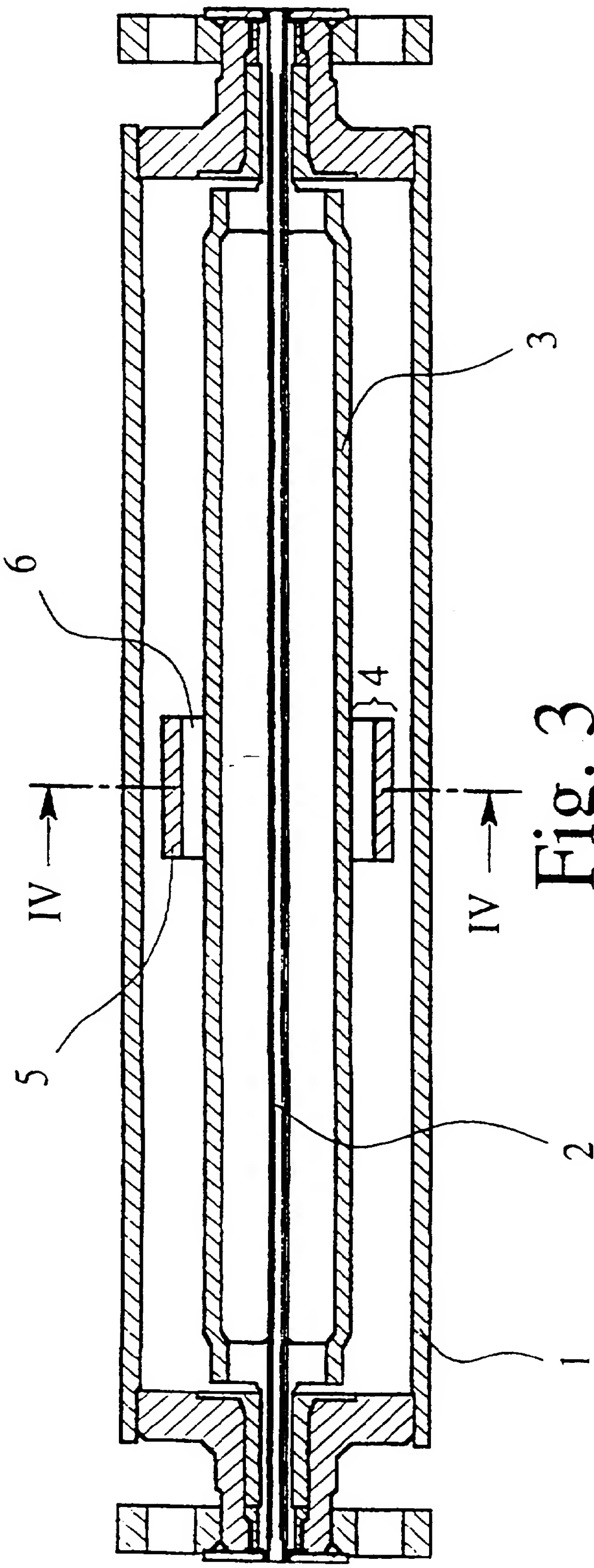

Fig. 3

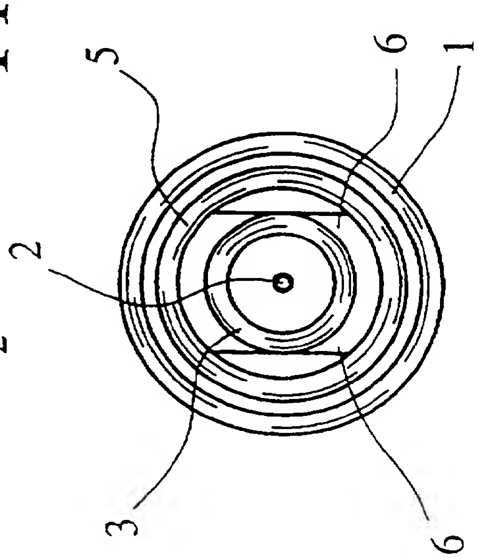

Fig. 4

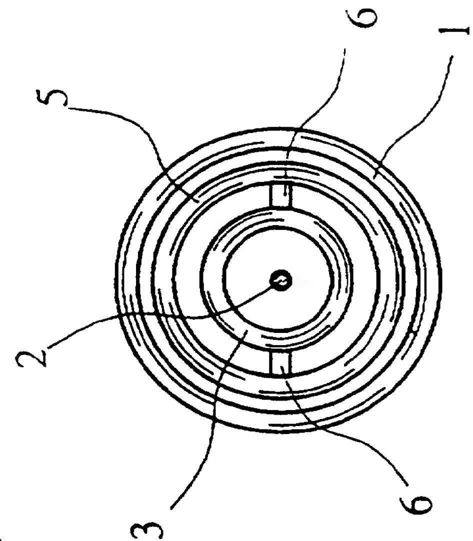

Fig. 5

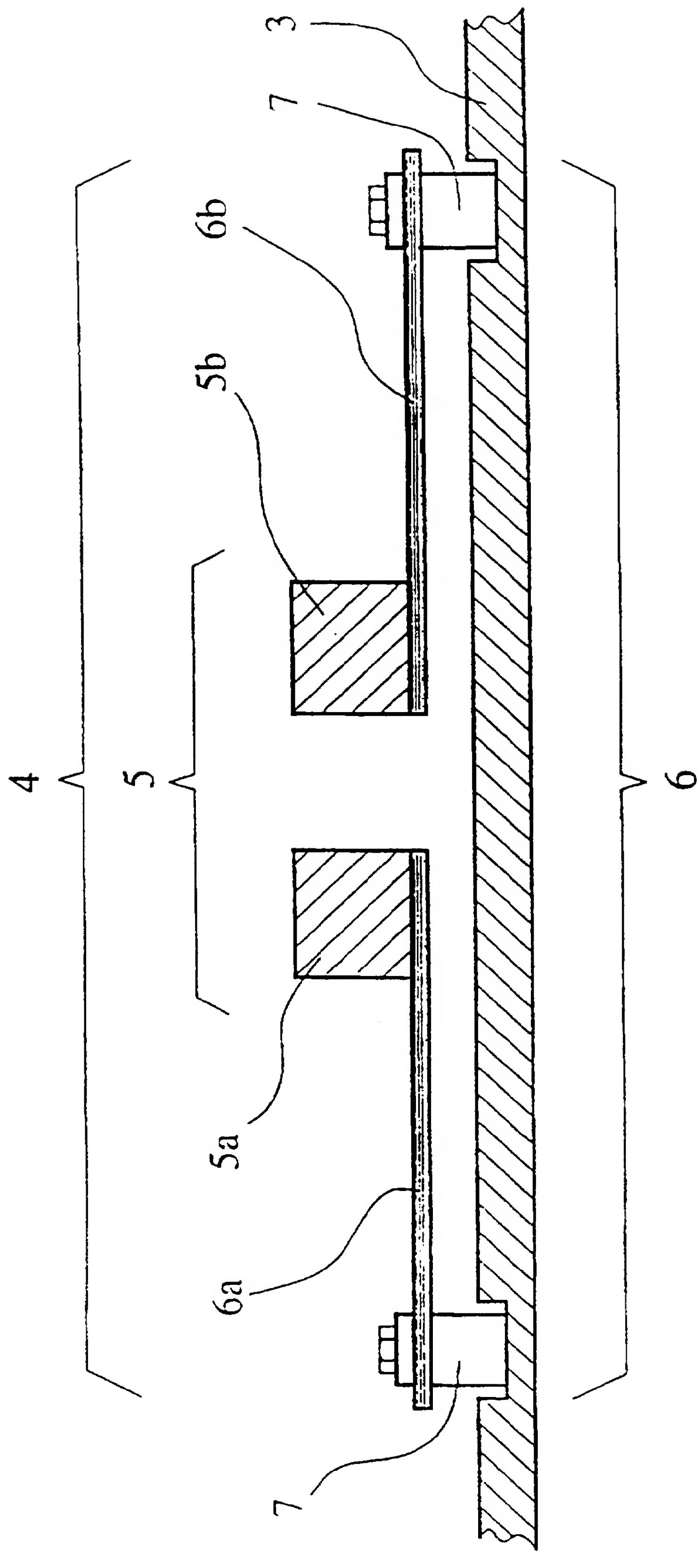

Fig. 6

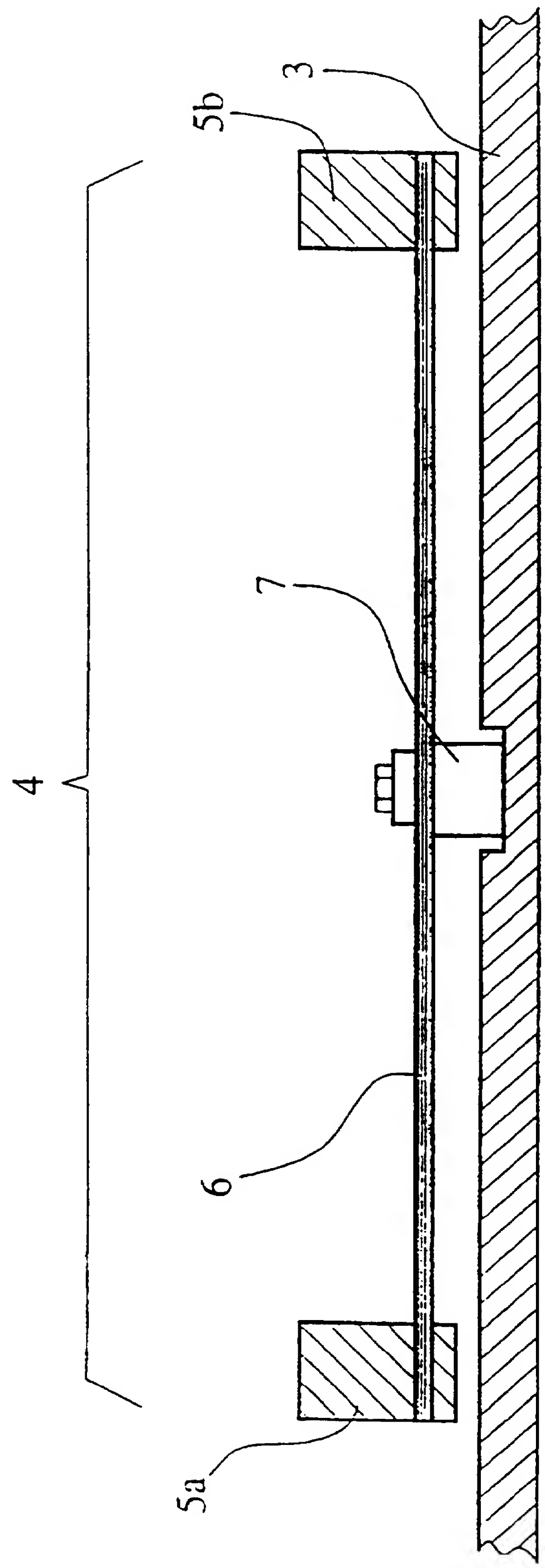

Fig. 7

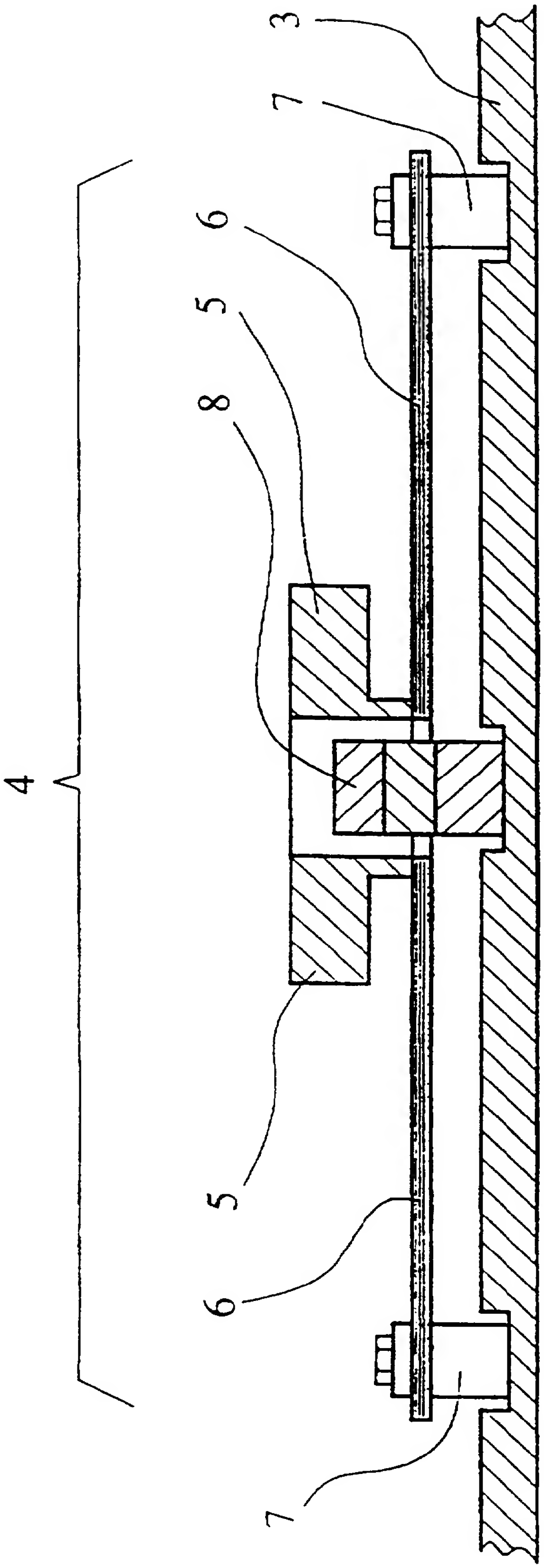

Fig. 8

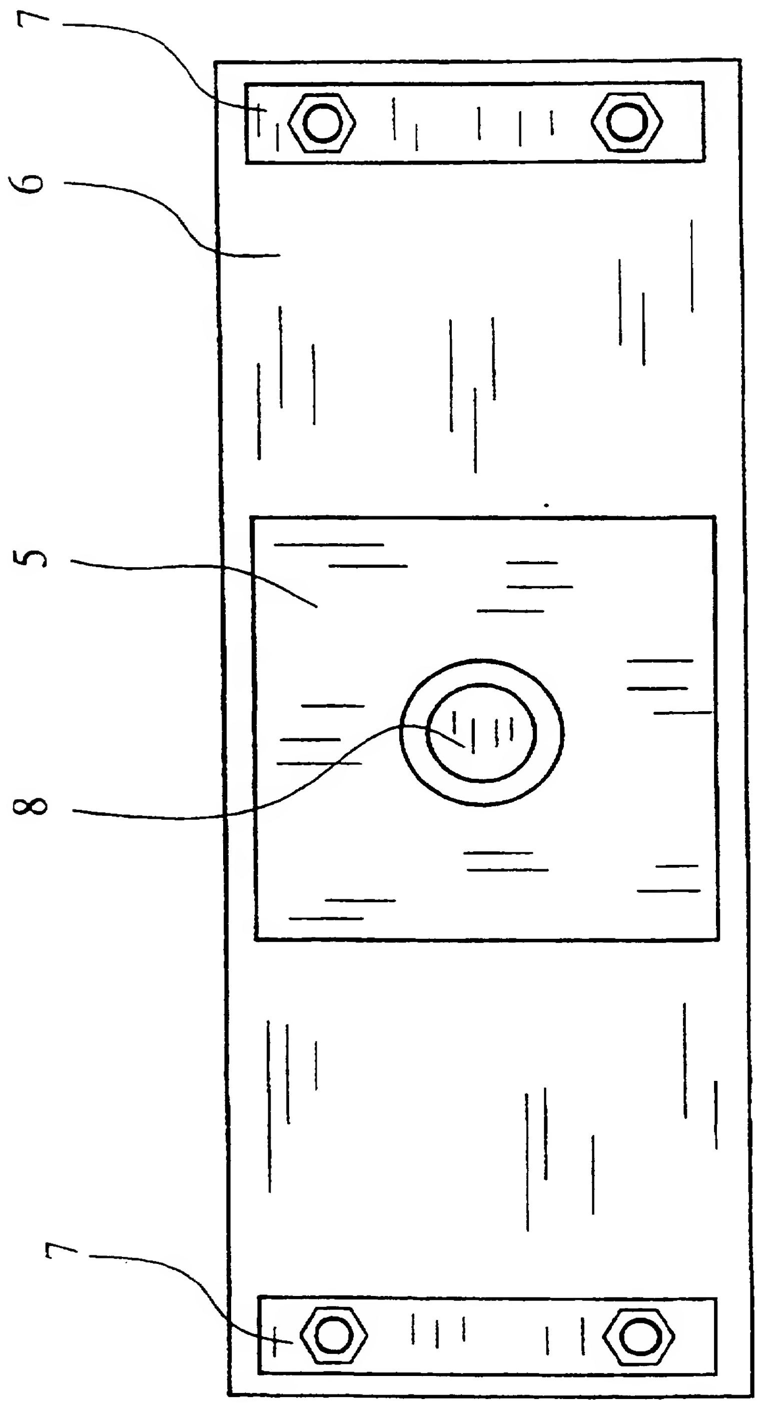

Fig. 9

This invention relates to a mass flow measuring device for flowing media which operates based on the Coriolis principle, having a housing which is preferably cylindrical, particularly circularly cylindrical, having at least one Coriolis measuring tube which is disposed inside the housing and is attached at both its ends to the housing, and which is preferably substantially straight, having a bridge which is disposed on the Coriolis measuring tube and which is preferably cylindrical, particularly circularly cylindrical, having at least one vibration generator which acts on the Coriolis measuring tube, and having at least one measuring sensor which records Coriolis forces and/or Coriolis vibrations based on Coriolis forces, wherein the bridge is symmetrically disposed and is symmetrically constructed in relation to the mid-point of the Coriolis measuring tube with respect to the ends of the Coriolis measuring tube which are attached to the housing, and wherein the vibration generator and the measuring sensor are effective between the Coriolis measuring tube and the bridge.

Mass flow measuring devices for flowing media which operate based on the Coriolis principle are known in various forms of construction (see German Patent Specification 41 24 295 and German Offenlegungsschrift 41 43 361 and the documents which are each listed therein in column 1, lines 20 to 27, German Patent Specification 42 24 397 and the documents listed therein in column 1, lines 23 to 30, as well as German Offenlegungsschrift 196 01 342, for example) and are increasingly being used in practice.

For mass flow measuring devices for flowing media which operate based on the Coriolis principle, a distinction is made in principle, firstly between those where the Coriolis measuring tube is at least substantially of straight construction and is generally of exactly straight construction, and secondly those where the Coriolis measuring tube is constructed in the shape of a loop. For mass flow measuring devices of the type in question a distinction is also made between firstly those which only have one Coriolis measuring tube and secondly those which have two Coriolis measuring tubes. In forms of construction with two Coriolis measuring tubes the latter may be disposed in series or in parallel with each other as regards flow.

Mass flow measuring devices of the type in question in which the Coriolis measuring tube is of straight design or the Coriolis measuring tubes are of straight design are simple as regards their

mechanical construction and can consequently be manufactured at relatively low cost. In this respect the internal surfaces of the Coriolis measuring tube or of the Coriolis measuring tubes can also be machined easily, e.g. they can be polished. Moreover they exhibit a low pressure loss. A disadvantage which can arise in mass flow measuring devices which operate based on the Coriolis principle and in which the Coriolis measuring tube is of straight construction or the Coriolis measuring tubes are of straight construction is that both thermally induced expansions or thermally induced stresses and forces and moments acting from the outside can result in errors of measurement and in mechanical damage, namely to stress cracking.

Experts in this field have already looked into the aforementioned problems of mass flow measuring devices with straight Coriolis measuring tubes (in particular, see German Patent Specification 41 24 295, German Offenlegungsschrift 41 43 361 and German Patent Specification 42 24 379). These problems have substantially ben solved, firstly by joining the Coriolis measuring tube and the bridge to each other in a manner which rules out axial relative movements, so that the axial spacing of the Coriolis measuring tube/bridge points of attachment constitutes the vibrating length of the Coriolis measuring tube, and secondly by disposing the Coriolis measuring tube inside the bridge under a tensile prestress (German Patent Specification 41 24 295), and/or by making the Coriolis measuring tube and the bridge of materials which have the same or almost the same coefficients of thermal expansion (German Offenlegungsschrift 41 43 361) and/or by providing a length change sensor - for correcting the measured value depending on the vibrating length and on stress - which determines changes in the vibrating length of the Coriolis measuring tube (German Patent Specification 42 24 379). Overall, success has been achieved in the creation of a mass flow measuring device, which operates based on the Coriolis principle and which has a straight measuring tube, which has an error of measurement of only about 0.1 % (see the brochure "Authorisation of the Corimass G instrument for calibration service" of the company KROHNE Meßtechnik GmbH & Co. KG).

Mass flow measuring devices which operate based on the Coriolis principle and which only have one straight Coriolis measuring tube have significant advantages compared with those mass flow measuring devices which have either two straight Coriolis measuring tubes or a Coriolis measuring tube in the shape of a loop. Their advantage compared with mass flow measuring

devices with two straight Coriolis measuring tubes is primarily manifested in that flow splitters or flow concentrators, which are required with mass flow measuring devices which have two Coriolis measuring tubes, are not necessary. Compared with mass flow measuring devices which have a Coriolis measuring tube in the shape of a loop or which have two Coriolis measuring tubes in the shape of loops, their main advantages are that a straight Coriolis measuring tube can be manufactured more easily than a Coriolis measuring tube in the shape of a loop, that the pressure drop in a straight Coriolis measuring tube is less than in a Coriolis measuring tube in the shape of a loop, and that a straight Coriolis measuring tube can be cleaned more effectively than a Coriolis measuring tube in the shape of a loop.

However, mass flow measuring devices which operate based on the Coriolis principle and which have one straight Coriolis measuring tube also have a disadvantage which is physically or mechanically predetermined (see European Patent Specification 0 521 439):

Mass flow measuring devices which operate based on the Coriolis principle require that the Coriolis measuring tube or Coriolis measuring tubes be set in vibration, with the aid of at least one vibration generator; in fact the Coriolis forces or Coriolis vibrations result from the fact that the Coriolis measuring tube vibrates or that the Coriolis measuring tubes vibrate, and from the mass flow through the Coriolis measuring tube or Coriolis measuring tubes.

In mass flow measuring devices which have two straight Coriolis measuring tubes or which have one Coriolis measuring tube in the shape of a loop, or which have two Coriolis measuring tubes in the shape of loops, the Coriolis measuring tubes or the vibrationally effective part of the Coriolis measuring tubes in the shape of loops are of identical construction, and are generally arranged and vibrationally excited so that they vibrate against each other. The positive consequence of this is that the vibrating system as a whole is not effective externally as such. The position of the centre of mass remains constant and the forces which arise are counterbalanced. Consequently, no vibrations are introduced into the pipeline system in which a mass flow measuring device such as this is installed, and vibrations of the pipeline system do not affect the measured result.

In mass flow measuring devices which operate based on the Coriolis principle and which only have one straight Coriolis measuring tube, the aforementioned positive consequence of Coriolis measuring tubes vibrating against each other does not of course occur. The centre of mass does not remain constant, and the forces which arise are not counterbalanced. The result of this is firstly that vibrations are transmitted into the pipeline system in which a mass flow measuring device such as this is installed, and secondly that vibrations of the pipeline system can affect the measured result.

In order to curb the aforementioned problems which are inherent in mass flow measuring devices which operate based on the Coriolis principle and which only have one straight Coriolis measuring tube, the pipeline system in which a mass flow measuring device is installed is frequently clamped in addition. As a rule, the pipe conveying the flowing medium to the mass flow measuring device and the pipe conveying the flowing medium away from the Coriolis are clamped at a spacing which corresponds to ten to fifteen times the pipe diameter.

In connection with the aforementioned problems which are inherent in mass flow measuring devices which operate based on the Coriolis principle and which only have one straight Coriolis measuring tube, it has already been proposed that what are termed anti-resonators, which should have a resonance spectrum of predetermined band width which is tuned to at least one resonant vibration of the Coriolis measuring tube, be provided at the locations where the Coriolis measuring tube is clamped (see European Patent Specification 0 521 439). However, it has been shown that a measure such as this does not result in an overall improvement for mass flow measuring devices which are already operating very accurately anyway.

It was stated in the introduction that a bridge disposed on the Coriolis measuring tube forms part of the mass flow measuring device from which the present invention stems. Other terms are also used in the prior art for these bridges, namely "compensation cylinder" (in German Patent Specification 41 24 295 and in German Offenlegungsschrift 41 43 361) or "supporting tube" (in German Patent Specification 42 24 379). The term "bridge" is used here to describe that which has been described elsewhere as a "compensation cylinder" or "supporting tube". The general expression "bridge" has been used because this component does not have to be a cylinder or a

tube. The only essential features are the cooperation of the Coriolis measuring tube and the bridge, with the effect that the axial spacing of the Coriolis measuring tube/bridge points of attachment predetermines the excited region of the Coriolis measuring tube which is necessary for its operation, and the symmetrical construction of the bridge in relation to the mid-point of the Coriolis measuring tube with respect to the ends of the Coriolis measuring tube which are attached to the housing.

It was also stated at the outset that at least one vibration generator which acts on the Coriolis measuring tube, and at least one measuring sensor which records Coriolis forces and/or Coriolis vibrations based on Coriolis forces, form part of the mass flow measuring device from which the present invention stems, and that the vibration generator and the measuring sensor are effective "between the Coriolis measuring tube and the bridge". By this it is meant that the Coriolis measuring tube is excited to execute vibrations with respect to the bridge, and that Coriolis forces or Coriolis vibrations which arise between the Coriolis measuring tube and the bridge are detected by the measuring sensor, generally by two measuring sensors.

The underlying object of the present invention is to improve the known mass flow measuring device which operates based on the Coriolis principle, and from which the present invention stems, as regards the problems mentioned above in detail which result from the mass flow measuring device having only one straight Coriolis measuring tube.

The mass flow measuring device according to the invention with which the object which was introduced and explained in detail above is achieved is firstly and substantially characterised in that the bridge is provided with a compensating system which is substantially symmetrically disposed and symmetrically constructed in relation to the mid-point. The compensating system itself is preferably a system capable of vibration, consisting of a compensating mass and of a compensating spring. As explained at the outset, the design according to the invention is particularly advantageous in association with a mass flow measuring device which has one measuring tube of straight construction. Moreover, the isolation of vibration which is aimed at according to the invention can also advantageously be used in association with one curved

measuring tube or with a plurality of straight or curved measuring tubes, the centre of mass of which is not at rest without the provision of a compensating system.

What is to be achieved by the teaching of the invention is that for a mass flow measuring device according to the invention, even if it only has one straight Coriolis measuring tube, the vibrating system as a whole has almost no effect externally, or at least has no effect as such. Consequently, the aim should be to design the compensating system so that the vibrational amplitude of the bridge is very small, and preferably so that it tends towards zero. The corresponding design of the compensating system can be determined empirically by one skilled in the art. However, he can also - or for the empirical design - take into consideration that the following equation is applicable to a first approximation:

$$\frac{X_1 K_1}{F_0} = \frac{\left|1-\left(\frac{W}{W_{22}}\right)^2\right|}{\left[1+\frac{K_2}{K_1}-\left(\frac{W}{W_{11}}\right)^2\right]\left[1-\left(\frac{W}{W_{22}}\right)^2\right]-\frac{K_2}{K_1}}$$

where

X_1 = the vibrational amplitude of the bridge,
K_1 = the spring stiffness of the bridge,
K_2 = the spring stiffness of the compensating system,
W = the resonant frequency of the Coriolis measuring tube,
W_{11} = the resonant frequency of the bridge,
W_{22} = the resonant frequency of the compensating system, and
F_0 = the force with which the Coriolis measuring tube is excited.

The parameters indicated above are preferably employed as a whole so that the resonant frequency of the compensating system in the direction of vibration parallel to the direction of vibration of the Coriolis measuring tube corresponds to the resonant frequency of the Coriolis

measuring tube. However, the resonant frequency of the compensating system can also be selected so that it corresponds to X times or 1/X times the resonant frequency of the Coriolis measuring tube, where X is an integer.

The arrangement of the symmetrically constructed compensating system symmetrically in relation to the mid-point of the Coriolis measuring tube with respect to the ends of the Coriolis measuring tube which are attached to the housing ensures that the compensating system only transmits minimal torsional vibrations about said mid-point of the Coriolis line into the bridge. It is particularly important to prevent these coupling effects, since vibrations of the bridge of this type about said mid-point couple strongly to the antisymmetrical vibrations of the Coriolis measuring tube in the Coriolis mode. Said coupling is therefore particularly pronounced and has a correspondingly great effect on the accuracy of measurement, since a vibration about the mid-point of the Coriolis measuring tube is just as antisymmetrical as the vibration in the Coriolis mode for a Coriolis measuring tube which is excited in fundamental vibration.

Apart from the arrangement of the compensating system substantially at the mid-point of the Coriolis measuring tube with respect to the ends of the Coriolis measuring tube which are attached to the housing, the tendency of the bridge to vibrate about its mid-point is further reduced in that the resonant frequency of the compensating system in the directions of vibration perpendicular to the direction of vibration of the Coriolis measuring tube - particularly in the direction of the connecting line between the points of attachment of the ends of the Coriolis measuring tube and the housing - corresponds to a frequency which differs significantly from the resonant frequency of the Coriolis measuring tube and from integral multiples or fractions thereof. This measure ensures that the compensating system is not excited to execute vibrations perpendicular to the direction of vibration of the Coriolis measuring tube, which in turn would lead to vibrations of the bridge about the mid-point, and also ensures that any existing vibrations of the compensating system in directions of vibration perpendicular to the direction of vibration of the Coriolis measuring tube cannot couple with the vibration in the Coriolis mode, so that the accuracy of measurement is significantly increased as a result.

Furthermore, the mass flow measuring device according to the invention is subjected to an additional measure in order to improve the accuracy of measurement by making the compensating system adjustable along the connecting line between the points of attachment between the Coriolis measuring tube and the housing. By means of this adjustment it is ensured that the compensating system can always be situated at the centre of mass of the assembly comprising the Coriolis measuring tube and the bridge. This adjustment is necessary since, due to manufacturing tolerances, the centre of mass of the assembly comprising the Coriolis measuring tube and the bridge is not always situated at the mid-point of the Coriolis measuring tube between the ends of the Coriolis measuring tube which are attached to the housing. A corresponding readjustment to what is exactly the centre of mass in turn reduces the possibility of the coupling of torsional vibrations about said centre of mass with the vibration of the Coriolis measuring tube.

In detail, a multiplicity of possibilities exists for fashioning and further developing the mass flow measuring device according to the invention. In this respect, reference is made firstly to the claims which are subsidiary to claim 1, and secondly to the description of preferred embodiments in connection with the drawings, where:

Figure 1 is a longitudinal section through a first embodiment of a mass flow measuring device according to the invention, where the vibration generator and measuring sensor are not illustrated;

Figure 2 is a longitudinal section, corresponding to that of Figure 1, through a second embodiment of a mass flow measuring device according to the invention;

Figure 3 is a longitudinal section, corresponding to that of Figure 1, through a third embodiment of a mass flow measuring device according to the invention;

Figure 4 is a cross-section through the embodiment of a mass flow measuring device according to the invention which is illustrated in Figure 3, along line IV-IV;

Figure 5 is a cross-section, corresponding to that of Figure 4, through a further embodiment of a mass flow measuring device according to the invention, the remainder of which is not illustrated;

Figure 6 illustrates, on an enlarged scale compared with Figures 1 to 5, part of a bridge forming part of a mass flow measuring device according to the invention, with a first embodiment of a specially constructed compensating system;

Figure 7 illustrates, on an enlarged scale compared with Figures 1 to 5, part of a bridge forming part of a mass flow measuring device according to the invention, with a second embodiment of a specially constructed compensating system;

Figure 8 illustrates, on an enlarged scale compared with Figures 1 to 5, part of a bridge forming part of a mass flow measuring device according to the invention, with a third embodiment of a specially constructed compensating system; and

Figure 9 is an aspect of the third embodiment of a specially constructed compensating system which is illustrated in Figure 8.

The mass flow measuring device for flowing media according to the invention is one which operates based on the Coriolis principle. The mass flow measuring device according to the invention comprises a housing 1, which in the embodiments illustrated is circularly cylindrical, a straight Coriolis measuring tube 2 which is disposed inside the housing 1 and which is attached at both its ends to the housing 1, a bridge 3 which is disposed on the Coriolis measuring tube 2 and which in the embodiments illustrated is circularly cylindrical, as well as components which are not illustrated in the Figures, namely at least one vibration generator which acts on the Coriolis measuring tube 2 and at least one measuring sensor which records Coriolis forces and/or Coriolis vibrations based on Coriolis forces.

As indicated in Figures 1 to 3, the Coriolis measuring tube 2 and the bridge 3 are attached to each other in a manner which prevents axial relative movements; the axial spacing between the

Coriolis measuring tube 2 / bridge 3 points of attachment constitutes the vibrating length of the Coriolis measuring tube 2 here. The bridge 3 is symmetrically disposed and symmetrically constructed in relation to the mid-point of the Coriolis measuring tube with respect to the ends of the Coriolis measuring tube which are attached to the housing.

The vibration generator, which is not illustrated, and the measuring sensor or measuring sensors, which are not illustrated, are effective between the Coriolis measuring tube 2 and the bridge 3. The manner in which the vibration generator and measuring sensor components, which are not illustrated, can be arranged in detail is shown in Figure 1 of German Patent Application 41 24 295 or of German Offenlegungsschrift 41 43 361, and in Figures 1, 2, 3 and 5 of German Patent Specification 42 24 379.

In the mass flow measuring devices of the type in question according to the invention, the bridge 3 is provided with a compensating system 4 which is symmetrically disposed and symmetrically designed in relation to the mid-point of the Coriolis measuring tube. The compensating system 4 is a system which is capable of vibration; namely it consists of a compensating mass 5 and a compensating spring 6, and is designed so that the vibrational amplitude of the bridge 3 is very small, and preferably so that it tends towards zero.

In the embodiments shown in Figures 1 and 2, the compensating system 4 is only provided on one side of the bridge 3. Figure 1 shows that the compensating spring 6 of the compensating system 4 is constructed as a leaf spring. The compensating spring 6 which is constructed as a leaf spring is attached to the bridge 3 via distance pieces 7 and the compensating mass 5 is disposed on the compensating spring 6. In contrast, the compensating spring 6 is constructed as a coil spring in the embodiment shown in Figure 2.

Whereas in the embodiments shown in Figures 1 and 2 the compensating system 4 is provided on one side of the bridge 3, in the embodiments shown in Figures 3 to 5 the compensating mass 5 of the compensating system 4 concentrically surrounds the bridge 3, which is of circular cylindrical construction. In the embodiment shown in Figures 3 and 4, the compensating mass 5 which concentrically surrounds the bridge 3 is attached to the bridge 3 via two compensating

springs 6 constructed as leaf springs, whilst in the embodiment shown in Figure 5 two compensating springs 6 constructed as coil springs are provided between the bridge 3 and the compensating mass 5 which concentrically surrounds the bridge 3. Since the vibration of the Coriolis measuring tube 2 generally occurs in one plane only, it may be advantageous if the compensating mass which surrounds the bridge 3 is of slightly eccentric construction.

Furthermore, Figure 6 shows a particular embodiment of the compensating system 4 which forms part of the mass flow measuring device according to the invention. The compensating system 4 consists here of two partial systems 4a, 4b, wherein the compensating mass 5 consists of two separate masses 5a, 5b and the compensating spring 6 consists of two separate springs 6a, 6b, and a separate mass 5a and 5b, respectively, is provided on each separate spring 6a and 6b, respectively. The two partial systems 4a, 4b of the compensating system 4 are disposed at a distance from each other.

Figure 7 illustrates an embodiment, which is an alternative to the embodiment illustrated in Figure 6, of a compensating system 4 forming part of the mass flow measuring device according to the invention. In this second embodiment of a specially constructed compensating system, the compensating spring 6 is of one-piece construction, is attached to the bridge 3 via a distance piece 7, and is provided with a separate mass 5a and 5b at each of the two ends of the compensating spring 6 remote from the distance piece 7.

In the embodiments of a specially constructed compensating system 4 illustrated in Figures 6 and 7, it is possible to vary the resonant frequency of said compensating system 4 and to adapt the resonant frequency of the Coriolis measuring tube, because the separate masses 5a and 5b are displaceable along the associated springs 6, 6a, 6b. This is particularly advantageous, since the Coriolis measuring tubes of two identical mass flow measuring devices generally have different resonant frequencies as a result of manufacturing tolerances.

The third embodiment of a specially constructed compensating system 4 which is illustrated in Figures 8 and 9 comprises a leaf spring 6, a central compensating mass 5 and a plurality of distance pieces 7 for fixing the leaf springs 6 to the bridge 3. As can be seen from Figures 8 and

9, the compensating mass 5, and accordingly the compensating springs 6, has a central recess into which a magnetic body 8 protrudes. Subject to the prerequisite that the compensating mass 5 and/or the compensating springs 6 consist of an electrically conductive material, the effect of this magnetic body 8 is to damp the vibration of the compensating system 4. This damping causes a change in the resonant frequency of the compensating system 4. If the magnetic body 8 is constructed as a permanent magnet, the damping, and thus the shift in resonant frequency, is constant, and can serve to compensate for manufacturing tolerances in the resonant frequency of the Coriolis measuring tube 2. As an alternative to its construction as a permanent magnet, the magnetic body 8 can also be constructed as an electromagnet. An embodiment of this type makes it possible to vary the damping of the compensating system 4 during the operation of the mass flow measuring device and thus simultaneously to vary the resonant frequency of the compensating system 4, and possibly to adapt the resonant frequency of the Coriolis measuring tube 2, which continuously alters during the operation of the mass flow measuring device, depending on the density and temperature of the flowing medium for example.

CLAIMS

1. A mass flow measuring device for flowing media which operates based on the Coriolis principle, having a housing which is preferably cylindrical, particularly circularly cylindrical, having at least one Coriolis measuring tube which is disposed inside the housing and is attached at both its ends to the housing, and which is preferably substantially straight, having a bridge which is disposed on the Coriolis measuring tube and which is preferably cylindrical, particularly circularly cylindrical, having at least one vibration generator which acts on the Coriolis measuring tube, and having at least one measuring sensor which records Coriolis forces and/or Coriolis vibrations based on Coriolis forces, wherein the bridge is symmetrically disposed and is symmetrically constructed in relation to the mid-point of the Coriolis measuring tube with respect to the ends of the Coriolis measuring tube which are attached to the housing, and wherein the vibration generator and the measuring sensor are effective between the Coriolis measuring tube and the bridge, **characterised in that** the bridge (3) is provided with a compensating system (4) which is substantially symmetrically disposed and symmetrically constructed in relation to the mid-point.

2. A mass flow measuring device according to claim 1, characterised in that the compensating system (4) is a system capable of vibration, namely it consists of a compensating mass (5) and of a compensating spring (6).

3. A mass flow measuring device according to claim 2, characterised in that the compensating system (4) is designed so that the vibrational amplitude of the bridge (3) is very small. and preferably tends towards zero.

4. A mass flow measuring device according to claim 2 or 3, characterised in that the resonant frequency of the compensating system (4) in the direction of vibration parallel to the direction of vibration of the Coriolis measuring tube (2) corresponds to the resonant frequency of the Coriolis measuring tube (2).

5. A mass flow measuring device according to claim 2 or 3, characterised in that the resonant frequency of the compensating system (4) in the direction of vibration parallel to the direction of vibration of the Coriolis measuring tube (2) corresponds to X times the resonant frequency or to 1/X times the resonant frequency of the Coriolis measuring tube (2) (where X is an integer).

6. A mass flow measuring device according to any one of claims 1 to 5, characterised in that the resonant frequency of the compensating system in the directions of vibration perpendicular to the direction of vibration of the Coriolis measuring tube (2) corresponds to a frequency which differs significantly from X times the resonant frequency or 1/X times the resonant frequency of the Coriolis measuring tube (2) (where X is an integer).

7. A mass flow measuring device according to any one of claims 1 to 6, characterised in that the compensating system (4) is adjustable along the connecting line between the points of attachment between the Coriolis measuring tube (2) and the housing (1).

8. A mass flow measuring device according to any one of claims 1 to 7, characterised in that the compensating system (4) is provided on one side of the bridge (3).

9. A mass flow measuring device according to any one of claims 2 to 8, characterised in that the compensating spring (6) of the compensating system (4) is constructed as a leaf spring.

10. A mass flow measuring device according to claim 9, characterised in that the compensating spring (6) which is constructed as a leaf spring is attached to the bridge (3) via distance pieces (7) and at least one compensating mass (5) is disposed on the compensating spring (6).

11. A mass flow measuring device according to claim 10, characterised in that the compensating mass (5) is disposed so that it is displaceable along the compensating spring (6).

12. A mass flow measuring device according to any one of claims 1 to 8, characterised in that the compensating spring (6) is constructed as a coil spring.

13. A mass flow measuring device according to any one of claims 1 to 7, characterised in that the compensating mass (5) of the compensating system (4) concentrically surrounds the bridge (3).

14. A mass flow measuring device according to claim 13, characterised in that the compensating mass (5) which concentrically surrounds the bridge (3) is attached to the bridge (3) via at least one compensating spring (6) constructed as a leaf spring.

15. A mass flow measuring device according to claim 13, characterised in that the compensating mass (5) which concentrically surrounds the bridge (3) is attached to the bridge (3) via at least one compensating spring (6) constructed as a coil spring.

16. A mass flow measuring device according to according to any one of claims 11, 13 or 14, characterised in that the compensating system (4) consists of two partial systems (4a, 4b), namely the compensating mass (5) consists of two separate masses (5a, 5b) and the compensating spring (6) consists of two separate springs (6a, 6b), and a separate mass (5a and 5b, respectively) is provided on each separate spring (6a and 6b, respectively).

17. A mass flow measuring device according to claim 16, characterised in that the two partial systems (4a, 4b) of the compensating system (4) are disposed at a distance from each other.

18. A mass flow measuring device according to any one of claims 11, 13 or 14, characterised in that the compensating system (4) comprises one compensating spring (6) and two separate masses (5a, 5b) fixed to the compensating spring (6).

19. A mass flow measuring device according to any one of claims 2 to 18, characterised in that a magnetic body (8) which interacts with the compensating mass (5) and/or with the compensating spring (6) is disposed on the measuring bridge (3).

20. A mass flow measuring device according to claim 19, characterised in that the magnetic body (8) is constructed as a permanent magnet, or - preferably - as an electromagnet.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 97/01332

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01F1/84

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 598 287 A (OVAL CORP) 25 May 1994 see page 5, line 2 - line 8 see page 10, line 13 - line 39; figures 3,10-12 ---	1
A	DE 41 43 361 A (KROHNE AG) 4 March 1993 cited in the application see column 2, line 56 - line 60; figure 1 ---	1
A	EP 0 521 439 A (ROTA YOKOGAWA GMBH & CO KG) 7 January 1993 cited in the application see abstract; figure 1 --- -/--	1,2

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

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Date of the actual completion of the international search	Date of mailing of the international search report
23 June 1997	14.07.97

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Inte. .ional Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 95 04259 A (MMG AUTOMATIKA MUVEK RESZVENYT ;ALESZ JOZSEF (HU); BUSZNYAK IMRE () 9 February 1995 see page 1; figure 7 -----	1

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